

Claims

1. A method of determining a bidding strategy for the simultaneous purchase of at least one individual service component from one or more on-line forward auctions, and the provision of a composite service requested by an on-line reverse auction, the method comprising:
  - identifying forward auctions selling the at least one individual service component;
  - identifying a reverse auction requesting a composite service comprising the at least one service component;
  - determining a plurality of possible combinations of the identified forward and reverse auctions;
  - estimating the expected benefit of bidding in each of the plurality of possible combination of auctions by use of likelihood models, wherein a reverse auction is modelled as a negative forward auction, and each likelihood model establishes the likelihood of a particular bid succeeding in a given auction; and
  - selecting the combination of auctions which provides the highest expected benefit, for use as the bidding strategy.
2. A method according to Claim 1, wherein the determining step comprises determining all possible combinations of the identified forward and reverse auctions.
3. A method according to Claim 1 or Claim 2, further comprising determining rules for defining which ones of individual service components form the composite service requested in the reverse auction.
4. A method according to any preceding claim, wherein the one or more on-line forward auctions comprises an English auction.
5. A method according to any of Claims 1 to 3, wherein the one or more on-line forward auctions comprises an offer for the sale of a service component at a fixed-price.
6. A method according to any preceding claim, wherein the on-line reverse auction comprises a reverse English auction.

7. A method according to any of Claims 1 to 5, wherein the on-line reverse auction comprises a request for the purchase of a composite service at a fixed-price.
8. A method according to Claim 4 or Claim 6, wherein likelihood models for the forward and reverse auctions,  $a$ , are given by a price distribution  $P_a : Z \Rightarrow [0,1]$  which represents the belief that auction  $a$  will close at price  $p$  with probability  $P_a(p)$ , where  $Z$  is a real number.
9. A method according to Claim 5 or Claim 7, wherein the likelihood models for the forward and reverse auctions,  $a$ , are given by a price distribution  $P_a(x) = 1$  if  $x = p$ , and 0 otherwise, which represents the belief that auction  $a$  will close at price  $p$  with 100% probability.
10. A method according to any preceding claim, wherein the considering step further comprises removing from the plurality of possible combinations of auctions, sets of auctions for which the individual service components do not match the composite service request, such that each of the plurality of possible combination of auctions contains a reverse auction and at least one forward auction.
11. A method according to Claim 10, wherein the removing step is carried out prior to placing a bid in the one or more forward auctions and making an offer in the reverse auction.
12. A method according to any of Claims 1 to 9, wherein the estimating step comprises estimating the future benefit,  $E_c$ , of bidding in a set of auctions  $B$ , given a set of observed prices  $q$ , and given that active bids are held in auctions  $A$ , by the following algorithm:
- $$E_c(B, A, q) = E(B, A, q) + \sum_{B \subset S \subset A \cup B} P_{ret}(S, A, q) \left( (V(S) - V(B)) - \sum_{a \in S \setminus B} q(a) \right), \text{ where}$$
- $S$  is the set of auctions in  $A \cup B$ ,  $E(B, A, q)$  is the expected benefit of the set of auctions  $B$ , given a set of observed prices  $q$ , and given that active bids are held in auctions  $A$ ,  $P_{ret}(S, A, q)$  is given by  $(F_{AS}(q + 1) P_{SB}(q)) / F_{AB}(q)$  where  $F_a$  is the probability that the auctions  $a$  will close at or above the prices  $q$ ,  $F_a(p)$  is given by  $\sum_{p \geq p'} P_a(p')$ ,  $V(S)$  is the valuation of the set of auctions  $S$ , and  $V(B)$  is the valuation of a given set of services in  $B$ .

13. A method according to Claim 10 or Claim 11, wherein the estimating step comprises estimating the future benefit,  $E_c$ , of bidding in a set of auctions  $B$ , given a set of observed prices  $q$ , and given that active bids are held in auctions  $A$ , by the following algorithm:

$$E_c(B, A, q) = E(B, A, q) + \sum_{a \in A \setminus B} P_{win}(a, q(a), q(a))(v(a) - q(a)),$$

5 where  $S$  is the set of auctions in  $A \cup B$ ,  $E(B, A, q)$  is the expected benefit of the set of auctions  $B$ , given a set of observed prices  $q$ , and given that active bids are held in auctions  $A$ ,  $P_{win}$  is the probability of a bid at price  $p \geq q$  winning if the price in auction  $a$  is  $q$ , and  $v(a)$  is the exogenous value of a service  $a$ .

10 14. A method according to Claim 12 or Claim 13, wherein the expected benefit  $E(B, A, q)$  is given by the following expression:

$$E(B, A, q) = V(B) - C(B \cap A, q) - C(B \setminus A, q + 1)$$

where the function  $C(S, q')$  is the expected cost of winning the auctions  $S$  at prices greater than or equal to  $q'$ , where  $C(S, q')$  is given by  $\sum_{p \geq q'} \sum_{a \in S} P_{win}(a, p(a), q'(a)) p(a)$ .

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15. A method according to Claim 14, wherein the values  $V(B)$  of the services in the set of auctions  $B$  are calculated prior to placing bids in the forward and reverse auctions.

16. A method according to any preceding claim, further comprising obtaining the closing prices of specific auctions in forward and reverse auctions, and creating a likelihood model for each auction from the closing price information.

17. A method according to Claim 16, further comprising updating the likelihood models with the results of the implemented bidding strategy.

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18. A method of simultaneously bidding in forward and reverse auctions using a bidding strategy, the method comprising determining the bidding strategy according to any preceding claim, and placing the minimal bids in the optimal set of auctions to take the lead in the set of auctions in which leading bids are not held.

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19. A system for determining a bidding strategy for the simultaneous purchase of at least one individual service component from one or more forward on-line auctions, and the provision of a composite service requested by an on-line reverse auction, the composite service comprising at

least one individual service component, the system comprising: likelihood models for the forward and reverse auctions, each model being arranged to determine the likelihood of a particular bid succeeding in a given auction; and processing means arranged to access the likelihood models; to consider a plurality of possible combinations of forward and reverse  
 5 auctions; to estimate the expected benefit of bidding in each of the plurality of possible combination of auctions by use of the likelihood models, wherein a reverse auction is modelled as a negative forward auction; and to select the combination of auctions which provides the highest expected benefit, for use as the bidding strategy.

10 20. A system according to Claim 19, where the plurality of possible combinations of forward and reverse auctions comprises all possible combinations of forward and reverse auctions.

21. A system according to Claim 19 or Claim 20, wherein the processing means is further arranged to remove from the possible combinations of auctions, sets of auctions for which the  
 15 individual service components do not match the composite service request, such that each possible combination of auctions contains a reverse auction and at least one forward auction.

22. A data carrier comprising a computer program arranged to configure a computer to implement the method of any of Claims 1 to 18.

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23. A method of determining a bidding strategy for the simultaneous purchase of at least one individual service component from one or more forward auctions, and the provision of a composite service requested by a reverse auction, the method comprising:

identifying forward auctions selling the at least one individual service component;  
 25 identifying a reverse auction requesting a composite service comprising the at least one service component;

determining a plurality of possible combinations of the identified forward and reverse auctions;

estimating an expected benefit of bidding in each of the plurality of possible  
 30 combination of auctions; and

selecting a combination of auctions for bidding in to increase a total expected benefit.

24. A system for determining a bidding strategy for the simultaneous purchase of at least one individual service component from one or more forward auctions, and the provision of a

composite service requested by a reverse auction, the composite service comprising at least one individual service component, the system comprising: likelihood models for the forward and reverse auctions, each model being arranged to determine the likelihood of a particular bid succeeding in a given auction; and processing; means arranged to access the likelihood models;  
5 to consider a plurality of possible combinations of forward and reverse auctions; to estimate an expected benefit of bidding in each of the plurality of possible combination of auctions by use of the likelihood models; and to select a combination of auctions for bidding in to increase a total expected benefit.